Scoping suggestions for the risk and management of dust from the proposed Gateway Pacific terminal

Alexander Gillespie

1/15/2013

1. The base problem

Coal dust is an odorless, fine powdered form of dark brown to black dust created by the crushing, grinding, or pulverizing coal.[1] Its most explosive risk is in combustion and flammability. Coal dust also possesses the ability to cause, longer term, detrimental impacts upon both humans and animals. These impacts may appear wherever coal is obtained, stockpiled and, particularly, when it is transported, dumped or otherwise handled (e.g. loading, unloading). At all of these stages there is the likelihood for the release of small particulate matter (i.e., dust) in significant quantities. Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust (including coal dust) particles. The size of particles is directly linked to their potential for causing health problems. The EPA is particularly concerned about particles that are 10μm[2] or smaller in diameter because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

The proposed Gateway Pacific Terminal (GPT) at Cherry Point is estimated to have a capacity of approximately 54 million metric tons of goods annually, of which 48 million tons would be coal. If the GPT development goes ahead, it will be the largest coal exporting site in North America. To achieve these figures there will be an 80 to 105 acre stockyard at Cherry Point for the storage of coal, other cargo and associated machinery. One of the significant impacts from the proposed terminal, in addition to the direct impacts from the construction of the facility and associated transportation infrastructure, will be the escape of coal dust into the environment. This dust will come from the stockpiled coal itself, escape when coal is being unloaded from the train and moved onto ships. While the developers have proposed some mitigation measures to try to address coal dust emissions, they cannot guarantee that 100% of coal dust will be contained within the facility.

[1] Commonly, it is identified by its content of silicon dioxide which is most commonly found in nature with sand or quartz, with it containing less than 5% of free silica.
[2] One μm is a measure of length and is one-millionth of a metre (or 1/34 millionth of an inch)

The primary driving force for the creation of coal dust will be wind as stockpiled coal provides an erodible surface for the wind generation of particulate matter emissions. Such dispersals of dust from coal piles are primarily governed by conditions with fluctuating wind rather than wind with constant flow rate. The characteristics of fluctuating wind depend on the weather (e.g., wind speed, wind direction, stability), terrain roughness and particle size with smaller sized particles being much more likely to become airborne than heavier ones.[3] According to the Naval Research Laboratory, the Puget Sound region experiences two primary wind regimes. The most significant occurs in late Autumn, Winter, and early Spring, when southerly winds prevail. Most of the southerly winds occur in advance of approaching low pressure/frontal systems moving eastward across the Pacific Ocean. Sustained winds of 23-38 mph are commonly experienced. Gale velocities (39-54 mph) may occur in advance of the stronger low pressure/frontal systems. Storm force (>55 mph) winds are only rarely observed. An additional high wind event occurs occasionally during the winter season when a very intense cold front (referred to as an Arctic front) moves southward into northern Washington State. When the cold continental polar air mass behind the front reaches southern British Columbia, it flows southwestward through the Fraser River Valley and accelerates toward Bellingham. Gale force (39-54 mph) northeasterly winds at Bellingham and very cold temperatures are not uncommon with such an event.[4]

The purpose of this document is to describe the potential impacts of coal dust emissions from the proposed GPT and provide insights into what data would be needed to evaluate these impacts. Local emissions from these rail sources (e.g., unloading and general coal dust emissions from wagons while the trains are present at the terminal) would also need to be included in the cumulative estimation of total levels of escaping coal dust emissions for the terminal.

2. Indicators of significant risk

[3] US Environmental Protection Agency (2006). AP 42, Fifth Edition, Volume I Chapter 13: Miscellaneous Sources, 13.2.5 Industrial Wind Erosion, Technology Transfer Network, Clearinghouse for Inventories & Emission Factors. http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0205.pdf. Also, Vrins, E. et al. (1998). 'Monitoring and Control of Fugitive Coarse Dust Sources'. *Journal of Aerosol Science*. 29: 709-740. Vrins, E. (1996). 'Sampling Requirements for Estimating Fugitive Dust Emissions'. *Journal of Aerosol Science*. 27(l.): 571-572. Visser, G. (1992). 'A Wind Tunnel Study of Dust Emissions'. *Atmospheric Environment* 26: 1453-1460.

[4] Naval Research Laboratory (1996). *Puget Sound Area Heavy Weather Port Guide*. (NRL, California). Section 3.1.

In order to be approved, the GPT development must reconcile a large number of relevant standards of regulatory, legislative and other legal and policy instruments from regional, state, federal and international agencies that are indicators of significant risk. A summary of some of the more relevant standards are provided below:

- The Clean Air Act and associated National Ambient Air Quality Standards (NAAQS)
- Associated standards for the Prevention of Significant Deterioration regulations, and the State Implementation Plan.
- Associated standards promulgated by the North West Clean Air Agency (NWCAA) and Puget Sound Clean Air Agency (PSCAA)
- The Endangered Species Act
- The Fish And Wildlife Coordination Act
- The Magnus-Stevens Fishery Conservation and Management Act-Essential Fish Habitat
- The Pacific Salmon Treaty
- The Clean Water Act
- The State Water Pollution Control Act
- The Shoreline Management Act of Washington State.

3. The significant risks of coal dust associated with the stockpile

Evidence suggests that the prolonged spread and settlement of coal dust on natural environments may have a discernible impact, and that this may be detrimental to non-tolerant species.[5] Within the marine environment, evidence of the impact of rising rates of coal-dust related pollutants from airborne sources is still emerging.[6] However, what is clear is that over time, the concentration of fugitive coal particles that escape from point sources (e.g., industrial loading and storage facilities) via both normal operations and natural assistance (such as wind drift). These particles are likely to settle and accumulate around various points,

[5] Spencer, S. (2001). 'Effects of Coal Dust on Species Composition of Mosses and Lichens in an Arid Environment'. *Journal of Arid Environments* 49: 843-853. Spencer, S. (1997). 'Effects of Coal Dust on Plant Growth and Species Composition in an Arid Environment'. *Journal of Arid Environments* 37: 475–485.
[6] Bounds, W. (2007). 'Arsenic Addition to Soils from Airborne Coal Dust Originating at a Major Coal Shipping Terminal'. Water Air Soil Pollution (2007) 185:195–207.

into the ocean.[7] Although the implications of this evidence for species in the local environment are still being ascertained, further evidence suggests that at least three species of juvenile salmon (including Chinook and Chum), which use habitats which were detrimentally modified by a coal port, suffered a detrimental impact.[8] The importance of this linkage is in the fact that the Chinook salmon of Puget Sound (including the Straits of Juan De Fuca) is explicitly recognized as threatened with extinction, and listed under the ESA.[9] One of the populations of Chum salmon (Hood Canal), also resident in the Puget Sound, has been listed under the ESA as well.

The Chinook salmon of Puget Sound (including the Straits of Juan De Fuca) is explicitly recognized as threatened with extinction and it is listed under the ESA.[10] The Chinook is also subject to further conservation considerations under Fish and Wildlife Coordination Act, the Magnus-Stevens Fishery Conservation and Management Act-Essential Fish Habitat,[11] and international conservation efforts under the 1985 Pacific Salmon Treaty.[12] When this treaty was updated in 2008, new fishing regimes came to encompass, *inter alia*, Chinook Salmon and included responsibilities which sought to preserve the biological diversity of the Chinook resource and contribute to the restoration of currently depressed stocks by improving their abundance, productivity, genetic diversity and spatial structure over time.[13]

As a species listed under the ESA, both the Chinook and the Chum salmon have critical habitat that must be protected.[14] In this regard, the Puget Sound Salmon Recovery Plan[15] has placed considerable emphasis upon the restoration of the most important habitats of the Chinook salmon in this region, including amongst others, estuaries, floodplains, riparian areas and particularly important near shore (i.e., shoreline and marine) areas. In this regard, there has been considerable success with approximately 2,350 acres of habitat restoration

[7] Johnson, R. (2006). 'Coal Dust Dispersal Around a Marine Coal Terminal (1977–1999), British Columbia: The Fate of Coal Dust in the Marine Environment'. *International Journal of Coal Geology* 68: 57–69.
[8] Levings, C. (1985). 'Juvenile Salmonid Use of Habitats Altered by a Coal Port in the Fraser River Estuary, British Columbia'. *Marine Pollution Bulletin,* 16(6): 248 -254.
[9] See NOAA, *Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.* 50448 Federal Register / Vol. 76, No. 157 / Monday, August 15, 2011 / Proposed Rules.
[10] See NOAA, *Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.* 50448 Federal Register / Vol. 76, No. 157 / Monday, August 15, 2011 / Proposed Rules.
[11] Public Law 94-265.
[12] *The Treaty Between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon*. See in particular, article 3.
[13] See chapter 3 of Annex IV of the Treaty.
[14] See http://www.nmfs.noaa.gov/pr/pdfs/criticalhabitat/chinooksalmon.pdf
[15] National Marine Fisheries Service (2007). *Puget Sound Salmon Recovery Plan* (NOAA, Washington).

projects being completed from 2007 to 2011 in the 16 major river delta estuaries.[16] While this habitat restoration work is to be commended, the risks of a substantial vessel accident upon this habitat must be assessed.[17] The main issue that needs to be evaluated is whether the proposed GPT will impact upon the critical habitat of the Chinook salmon and whether the proposal would lead to an impact on any of the other important elements in the local food web. Specifically, this evaluation must be undertaken in relation the local sea-grass communities around Cherry Point and the herring that exists within it, and whether these elements are essential for the conservation success of the Chinook. It is particularly important to examine this as the evidence suggests that Cherry Point herring biomass remains at critically low levels with no sign of recovery.[18]

4. Alternatives

Coal stockpiles should not be placed in areas of high wind. Alternative, more settled locations, should always be sourced as the overt primary threat in all locations of stored coal, is wind strength and its persistence. That is, if coal stockpiles are in the wrong location, no amount of mitigation will stop the release of coal dust. As such, the first alternative must always be that where possible, the site should not be placed in a location with excessive amounts of wind.[19]

5. Mitigation

As far back as 1941, scientists have expended a great amount of effort in trying to understand and control the impact of wind upon particulate matter which can become airborne.[20] Many examples can be cited including the prevention of desert expansion and farmland erosion but of most relevance to this assessment is the examination of airborne coal dust emissions. The main focus of these investigations has been upon efforts to keep wind off the material which is volatile to being made airborne. Various mitigation options are available in this area (e.g.,

[16] PugetSoundPartnership (2012). *The 2012 State of the Sound: A Biennial Report on the Recovery of Puget Sound.* (PSP, Seattle). 22, 24.
[17] Ibid.
[18] PugetSoundPartnership (2012). *The 2012 State of the Sound: A Biennial Report on the Recovery of Puget Sound.* (PSP, Seattle). 22, 24.
[19] Cowherd, C. (1981). 'Control of Windblown Dust from Storage Piles'. *Environment International.* 6: 3
[20] Bagnold, R., 1941. The Physics of Blown Sand and Desert Dunes. (Methuen, London).

moisture, wind-breaks, pile geometry and management of the pile) that can, when combined, provide limited protection for a period of time. That period of time is always dependent on the elements that the stockpile is exposed to. Each of these mitigation measures should be critically examined.

Surfactants and wetting

One method that is being used more and more to reduce dust emissions is to ensure that the coal is made moist so that the particles are affixed to the bulk material. All tests show a strong response in reduction of dust emissions with increasing total moisture content. Each coal exhibits a critical moisture content around which no emissions occur. Assuming the correct amount and type of moisture is applied to the correlated particle then dust, if it is not exposed to excessive wind, can be greatly reduced. A similar alternative is to spray the coal with a surfactant or protective layer, such as polyoxyethylene and polyglycerol-based nonionic surfactants. This is achieved through using a water additive that forms a skin over the coal, thereby, keeping the dust in. If applied effectively, dust emissions can be reduced, in theory, by between 80 to 99%.[21] However, both water and protective layers can be negated by opposing forces of wind and excessive moisture (i.e., rain). If these forces are superior to the bonding agents, the fugitive dust will continue to escape, typically, downwind. While this approach is used on loaded coal wagons, surfactants other than standard water are not generally used on coal stockpiles but this issue should be examined. In particular, whilst looking at the option of wetting, it will be necessary to study the impacts of the water required, in terms of both quantity, quality and the indirect effects this may have on associated ecosystems.

Wind barriers

The second mitigation option is the utilization of barriers, such as fencing, bunding, shelter-belts or windbreaks to prevent the potentially volatile material from becoming airborne. Evidence already suggests that if wind barriers are made of appropriate materials, are set at appropriate heights and depths (more than one layer), and configurations (e.g., rectangles, octagons, open boxes, etc.) they can be effective in controlling the spread of dust, with

[21] Keystone Environmental (2011). *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Office of Environment and Heritage, KE1006953, NSW). Kim J. (1994). 'The Effect of Added Base on Coal Wetting Ability of Non-ionic Surfactant Solutions Used for Dust Control'. *Mining Engineer*, 154: 151-155. Smitham, J. (1991). 'Physico-Chemical Principles Controlling the Emission of Dust from Coal Stockpiles'. *Powder Technology*. 64(3): 259-270..

success rates (in ideal conditions) of up to 85%.[22] However, in order to achieve such high levels of mitigation, barriers must be optimally designed for the local conditions and built and maintained to a high standard.

Stockpile geometry

The third mitigation to be investigated is the geometry of the pile. The geometry of the stockpile (especially including the height, size, compaction and primary shape facing the dominant wind direction) can have a strong impact upon the amount of coal dust that is generated, with differences ranging from between 13 and 60% reductions in emissions (in ideal situations) when the correct shape is utilized.[23] However, as identified previously, to achieve these levels of mitigation, stockpiles must be optimally designed for the local conditions and continuously maintained to a consistently high standard.

Minimizing disturbance

The fourth mitigation is to ensure that already settled piles are disturbed as little as possible, as, over time, the surface of an undisturbed stockpile will become depleted in erodible material and emissions of particulate matter will reduce. If stockpiles are frequently disturbed, fresh surface material will be exposed, restoring the erosion potential and the problem will continue repeating itself. With respect to the handling of coal from the trains to the stockpiles, or the port to the vessel, best practice measures to control emissions are the use of volumetric loading from an overhead silo or bin with a telescopic chute with the entire activity enclosed within a set space.

---

[22] Cong, X. (2011). 'Impact of the Installation Scenario of Porous Fences on Wind-Blown Particle Emission in Open Coal Yards'. *Atmospheric Environment* 45 (2011) 5247e5253. Cheng, Y. (2010). 'An investigation into the sheltering performance of porous windbreaks under various wind directions'. *Journal of Wind Engineering and Industrial Aerodynamics*. 98: 520–532. Park, C. (2003). 'Experimental Study on Surface Pressure and Flow Structure Around a Triangular Prism Located Behind a Porous Fence'. *Journal of Wind Engineering and Industrial Aerodynamics* 91(1): 165–184. Lee, S. (2002). 'Wind Tunnel Observations about the Shelter Effect of Porous Fences'. *Atmospheric Environment* 36: 1453–1463. Park, C. (2002). Verification of the shelter effect of a windbreak on coal piles in the POSCO open storage yards at the Kwang-Yang works'. *Atmospheric Environment* 36: 2171. Lee, S., (1999). Laboratory Measurements of Velocity and Turbulence Field Porous Fences. *Journal of Wind Engineering and Industrial Aerodynamics* 80: 311–329. Stunder, B., (1988). 'Windbreak Effectiveness for Storage Pile Fugitive Dust Control'. *Journal of the Air Pollution Control Association* 38: 135–143. Borges, A., (1988). Shelter Effects on a Row of Coal Piles to Prevent Wind Erosion'. *Journal of Wind Engineering and Industrial Aerodynamics* 29: 145–154. US Environmental Protection Agency (1986), *Field Evaluation of Windscreens as a Fugitive Dust Control Measure for Material Storage Piles,* Document EPA/600/S7-86/027. Billman, B (1985). *Windbreak Effectiveness for Storage-Pile Fugitive Dust Control.* USEPA Report No. EPA/600/3 - 85/059.

[23] Cong, X. (2012). 'Effect of aggregate stockpile configuration and layout on dust emissions in an open yard'. *Applied Mathematical Modelling* 36: 5482–5491. Turpin, J. (2009). Numerical Modeling of Flow Structures over Various flat-Topped Stockpiles Height: Implications on Dust Emissions'. *Atmospheric Environment* 43: 5579–5587. Torano, R. (2007). 'Influence of the pile shape on wind erosion CFD emission simulation'. *Applied Mathematical Modelling* 31: 2487–2502. Badr, T. (2007). 'Effect of Aggregate Storage Piles Configuration on Dust Emissions'. *Atmospheric Environment* 41 (2007) 360–368. Badr, T. (2005). 'Numerical Modelling of Flow Over Stockpiles: Implications on Dust Emissions'. *Atmospheric Environment* 39: 5576–5584. IEA Coal Research (1994). *Control of Coal Dust in Transit and in Stockpiles.* (IEA, London).

Cover

While not commonly used for large coal stockpiles, an alternative that would reduce coal dust emissions by 100% is by storing it under cover. The largest industrial structures have a useable floor area of between 2 and 4+ million square feet (i.e., 98 acres) with useable volumes of 250-470+ million cubic feet[24]. While the cost of building such a facility would be considerable, there are equivalent precedents with the storage of other bulk items such as grain that must be kept under cover, generally in silos or bins, to keep it dry. Such an alternative should at least be considered as it should be for the covering of coal wagons during transport. Together, these options would reduce coal dust emissions for transport and storage to nearly zero.

6. Recommended research programs

Based on the assessment of the various risks posed by coal dust from the proposed GPT and a consideration of potential alternatives and potential mitigation options that are contained in this report, four research studies are recommended to assist in developing an understanding and evaluation of the impacts of the GPT.

(i). The first study that should be undertaken relates to the rate of coal dust emissions from stock piles, in addition to other local sources, such as conveyor belts, as well as emissions from rail sources within the terminal (e.g., unloading). With regards to the primary risk that are the coal stockpiles, this will require examination of geometry of the stockpile, how often they are moved (including reshaping, compacting and maintenance by bulldozers) and the composition of the coal itself (e.g., the size distribution of the coal particles and the chemical composition). Most importantly, this study should focus upon an understanding of factors that influence coal dust emission rates including wind strength, averages and extremes, needs to be mapped.

(ii). The second study needs to be built upon the conclusions of the first study. That is, once a clear view of the likely levels of emissions from the stockpile and associated

[24] Boeing Everett Tour Fact Sheet. Available at http://www.boeing.com/commercial/tours/background.html. Downloaded on 2nd January 2013.

activities is clear, these emissions should be juxtaposed against the adequacy of the possible mitigations of surfactants and wetting, wind barriers and enclosure. The adequacy of these mitigations then needs to be measured against the potential impacts the coal dust may have in the marine environment, and upon vulnerable species and ecosystems in particular.

(iii). The third study needs to examine the possibility of alternative locations which are not exposed to the dominant disturbing factors such as wind.

(iv). The fourth study needs to examine the the implications on the local freshwater ecosystems for mitigation techniques such as wetting, of which it will be necessary to study the impacts of the water required, in terms of both quantity, quality and the indirect effects this may have on associated ecosystems.